Claims

We claim:

1. A method for computing an average bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each said frame having a same number of fields, said BA equal to $(BR + BR1/J1)/J2$, said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said $BR1/BR$ a positive integer, said method comprising:

determining BR1, J1, and J2 such that $J2/(1+(BR1/BR)/J1)$ as evaluated in floating point is approximately equal to FR, said FR a frame rate in frames/sec;

calculating a quotient Q1 and remainder R1 from integer division of BR1 by J1;

calculating a quotient Q2 and remainder R2 from integer division of $(BR+Q1)$ by J2;

initializing to zero accumulators A1 and A2; and

executing N iterations, wherein $N > 1$, and wherein executing each iteration includes:

adding R1 to A1;

if $A1 \geq J1$, then adding 1 to A2 and decrementing A1 by J1;

setting $BA=Q2$ and adding R2 to A2;

if $A2 \geq J2$, then adding 1 to BA and decrementing A2 by J2.

2. The method of claim 1, wherein determining BR1, J1, and J2 includes computing BR1, J1, and J2.

3. The method of claim 1, wherein determining BR1, J1, and J2 includes receiving as input BR1, J1, and J2.

4. The method of claim 1, wherein J1 is a multiple of 10.

5. The method of claim 1, wherein J1 > J2.

6. A computer code that computes an average bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each said frame having a same number of fields, said BA equal to $(BR + BR1/J1)/J2$, said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said BR1/BR a positive integer, said computer code including an algorithm programmed to:

determine BR1, J1, and J2 such that $J2/(1+(BR1/BR)/J1)$ as evaluated in floating point is approximately equal to FR, said FR a frame rate in frames/sec;

calculate a quotient Q1 and remainder R1 from integer division of BR1 by J1;

calculate a quotient Q2 and remainder R2 from integer division of $(BR+Q1)$ by J2;

initialize to zero accumulators A1 and A2; and

execute N iterations, wherein $N > 1$, and wherein to execute each iteration includes:

to add R1 to A1;

if $A1 \geq J1$, then to add 1 to A2 and to decrement A1 by J1;

to set $BA=Q2$ and to add R2 to A2; and

if $A2 \geq J2$, then to add 1 to BA and to decrement A2 by J2.

7. The computer code of claim 6, wherein to determine BR1, J1, and J2 includes to compute BR1, J1, and J2.

8. The computer code of claim 6, wherein to determine BR1, J1, and J2 includes to receive as input BR1, J1, and J2.

9. The computer code of claim 6, wherein J1 is a multiple of 10.

10. The computer code of claim 6, wherein J1 > J2.

11. A method of computing an average bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each said frame having a variable number of fields, comprising:

defining BA1 as an average bits/frame for a two-field frame, said BA1 equal to (BR + BR1/J1)/J2, said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said BR1/BR a positive integer;

defining BA2 as an average bits/frame for a one-field frame, said BA2 equal to (BR + BR1/J1)/(2*J2);

determining BR1, J1, and J2 such that J2/(1+(BR1/BR)/J1) as evaluated in floating point is approximately equal to FR, said FR a frame rate in frames/sec;

calculating a quotient Q1 and remainder R1 from integer division BR1/J1;

calculating a quotient Q2 and remainder R2 from integer division (BR+Q1)/J2;

calculating a quotient Q3 and remainder R3 from integer division (BR+Q1)/(2*J2);

initializing to zero accumulators A1, A2, B1, and B2;

executing N iterations, wherein $N > 1$, said executing iteration n of N relating to extracting a frame n from the buffer, said executing of iteration n including:

calculating BA1, including:

adding R1 to A1;

if $A1 \geq J1$ then adding 1 to A2 and decrementing A1 by J1;

setting BA1=Q2 and adding R2 to A2;

if $A2 \geq J2$, then adding 1 to BA1 and decrementing A2 by J2;

determining a number of fields F_n comprised by the frame n;

if F_n is even then setting BA2=0 else calculating BA2 including:

adding R1 to B1;

if B1 $\geq$ J1, then adding 1 to B2 and decrementing B1 by J1;

setting BA2=Q3 and adding R3 to B2;

if B2 $\geq$ (2*J2), then adding 1 to BA2 and decrementing B2 by (2*J2);

computing BA=(F_n/2)*BA1 + BA2, said (F_n/2) computed by integer division.

12. The method of claim 11, wherein F_n is 2 or 3.

13. The method of claim 11, wherein determining BR1, J1, and J2 includes computing BR1, J1, and J2.

14. The method of claim 11 wherein determining BR1, J1, and J2 includes receiving as input BR1, J1, and J2.

15. The method of claim 11, wherein J1 is a multiple of 10.

16. The method of claim 11 wherein J1 > J2.

17. A computer code that computes an average bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each said frame having a variable number of fields, said BA a function of BA1 and BA2, said BA1 defined as an average bits/frame for a two-field frame, said BA1 equal to (BR + BR1/J1)/J2, said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said BR1/BR a positive integer, said BA2 defined as an average bits/frame for a one-field frame, said BA2 equal to (BR + BR1/J1)/(2*J2), said computer code including an algorithm, said algorithm programmed to:

determine BR1, J1, and J2 such that J2/(1+(BR1/BR)/J1) as evaluated in floating point is approximately equal to FR, said FR a frame rate in frames/sec;

calculate a quotient Q1 and remainder R1 from integer division BR1/J1;

calculate a quotient Q2 and remainder R2 from integer division (BR+Q1)/J2;

calculate a quotient Q3 and remainder R3 from integer division (BR+Q1)/(2*J2);

initialize to zero accumulators A1, A2, B1, and B2;

execute N iterations, wherein $N > 1$, said iteration n of N relating to extracting a frame n from the buffer, wherein to execute iteration n includes:

to calculate BA1, including:

to add R1 to A1;

if $A1 \geq J1$ then to add 1 to A2 and to decrement A1 by J1;

to set BA1=Q2 and to add R2 to A2;

if $A2 \geq J2$, then to add 1 to BA1 and to decrement A2 by J2;

to determine a number of fields F_n comprised by the frame n;

if F_n is even then to set BA2=0 else to calculate BA2 including:

to add R1 to B1;

if B1 $\geq$ J1, then to add 1 to B2 and to decrement B1 by J1;

to set BA2=Q3 and to add R3 to B2;

to compute BA=$(F_n/2)$*BA1 + BA2, said $(F_n/2)$ computed by integer division.

18. The computer code of claim 17, wherein F_n is 2 or 3.

19. The computer code of claim 17, wherein to determine BR1, J1, and J2 includes to compute BR1, J1, and J2.

20. The computer code of claim 17 wherein to determine BR1, J1, and J2 includes to receive as input BR1, J1, and J2.

21. The computer code of claim 17, wherein J1 is a multiple of 10.

22. The computer code of claim 17 wherein J1 > J2.

23. A method for computing Z, said $Z = \Sigma_n\ Z_n$, said Σ_n denoting a summation over n from 1 to N, said N a positive integer of at least 1, said $Z_n = X_n/Y$, said $X_n = (I_{1n}/J_1)M_{1n} + (I_{2n}/J_2)M_{2n} + \ldots + (I_{Kn}/J_K)M_{Kn}$, said Y and said I_{kn}, J_k, M_{kn} (k=1, 2, ..., K) each a positive integer, said K a positive integer of at least 1, said method comprising:

setting Z=0, B=0, and A_k=0 for k=1, 2, ..., K;

executing N iterations, said executing of iteration n of N including:

calculating a quotient Q_{kn} and a remainder R_{kn} from integer division I_{kn}/J_k for k=1, 2, ..., K;

calculating $X_n = \Sigma_k\ [Q_{kn}M_{kn}]$ as summed over k from 1 to K;

adding $R_{kn}M_{kn}$ to A_k for k=1, 2, ..., K;

for k = 1, 2, ..., K, if $A_k \geq J_k$, then adding 1 to B and decrementing A_k by J_k;

if $Y \neq 1$ then calculating a quotient Q_n and a remainder R_n from integer division X_n/Y, else setting $Q_n = X_n$ and $R_n = 0$;

setting $Z_n = Q_n$ and adding R_n to B;

if $B \geq Y$, then calculating $Z_n = Z_n + 1$ and decrementing B by Y;

adding Z_n to Z.

24. The method of claim 23, further comprising:

computing $S = B + \Sigma_k\ (A_k/J_k)]/Y)$, said $\Sigma_k\ (A_k/J_k)$ denoting a summation over k from 1 to K, said S computed in floating point; and

adding S to Z.

25. The method of claim 23, wherein $Y \neq 1$.

26. The method of claim 23, wherein $Y=1$.

27. A computer code that computes Z, said $Z = \Sigma_n\ Z_n$, said Σ_n denoting a summation over n from 1 to N, said N a positive integer of at least 1, said $Z_n = X_n/Y$, said $X_n = (I_{1n}/J_1)M_{1n} + (I_{2n}/J_2)M_{2n} + \ldots + (I_{Kn}/J_K)M_{Kn}$, said Y and said I_{kn}, J_k, M_{kn} (k=1, 2, ..., K) each a positive integer, said K a positive integer of at least 1, said computer code including an algorithm, said algorithm programmed to:

set Z=0, B=0, and A_k=0 for k=1, 2, ..., K;

execute N iterations, wherein to execute iteration n of N includes:

to calculate a quotient Q_{kn} and a remainder R_{kn} from integer division I_{kn}/J_k for k=1, 2, ..., K;

to calculate $X_n = \Sigma_k\ [Q_{kn}M_{kn}]$ as summed over k from 1 to K;

to add $R_{kn}M_{kn}$ to A_k for k=1, 2, ..., K;

for k = 1, 2, ..., K, if $A_k \geq J_k$, then to add 1 to B and to decrement A_k by J_k;

if $Y \neq 1$ then to calculate a quotient Q_n and a remainder R_n from integer division X_n/Y, else to set $Q_n = X_n$ and $R_n = 0$;

to set $Z_n = Q_n$ and to add R_n to B;

if $B \geq Y$, then to calculate $Z_n = Z_n + 1$ and to decrement B by Y;

to add Z_n to Z.

28. The computer code of claim 27, said algorithm further programmed to:

compute $S = [B + \Sigma_k\ (A_k/J_k)]/Y$, said $\Sigma_k\ (A_k/J_k)$ denoting a summation over k from 1 to K, said S computed in floating point; and

add S to Z.

29. The computer code of claim 27, wherein $Y \neq 1$.

30. The computer code of claim 27, wherein $Y=1$.

31. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, wherein the computer code computes an average bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each said frame having a same number of fields, said BA equal to (BR + BR1/J1)/J2, said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said BR1/BR a positive integer, said computer code including an algorithm programmed to:

determine BR1, J1, and J2 such that J2/(1+(BR1/BR)/J1) as evaluated in floating point is approximately equal to FR, said FR a frame rate in frames/sec;

calculate a quotient Q1 and remainder R1 from integer division of BR1 by J1;

calculate a quotient Q2 and remainder R2 from integer division of (BR+Q1) by J2;

initialize to zero accumulators A1 and A2; and

execute N iterations, wherein $N > 1$, and wherein to execute each iteration includes:

to add R1 to A1;

if $A1 \geq J1$, then to add 1 to A2 and to decrement A1 by J1;

to set BA=Q2 and to add R2 to A2; and

if $A2 \geq J2$, then to add 1 to BA and to decrement A2 by J2.

32. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, wherein the computer code computes an average bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each said frame having a variable number of fields, said BA a function of BA1 and BA2, said BA1 defined as an average bits/frame for a two-field frame, said BA1 equal to (BR + BR1/J1)/J2, said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said BR1/BR a positive integer, said BA2 defined as an average bits/frame for a one-field frame, said BA2 equal to (BR + BR1/J1)/(2*J2), said computer code including an algorithm, said algorithm programmed to:

determine BR1, J1, and J2 such that J2/(1+(BR1/BR)/J1) as evaluated in floating point is approximately equal to FR, said FR a frame rate in frames/sec;

calculate a quotient Q1 and remainder R1 from integer division BR1/J1;

calculate a quotient Q2 and remainder R2 from integer division (BR+Q1)/J2;

calculate a quotient Q3 and remainder R3 from integer division (BR+Q1)/(2*J2);

initialize to zero accumulators A1, A2, B1, and B2;

execute N iterations, said N at least 1, said iteration n of N relating to extracting a frame n from the buffer, wherein to execute iteration n includes:

to calculate BA1, including:

to add R1 to A1;

if A1≥J1 then to add 1 to A2 and to decrement A1 by J1;

to set BA1=Q2 and to add R2 to A2;

if A2≥J2, then to add 1 to BA1 and to decrement A2 by J2;

to determine a number of fields F_n comprised by the frame n;

if F_n is even then to set BA2=0 else to calculate BA2 including:

to add R1 to B1;

if B1 ≥ J1, then to add 1 to B2 and to decrement B1 by J1;

to set BA2=Q3 and to add R3 to B2;

to compute BA=(F_n/2)*BA1 + BA2, said (F_n/2) computed by integer division.

33. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, wherein the computer code computes Z, said $Z = \Sigma_n Z_n$, said Σ_n denoting a summation over n from 1 to N, said N a positive integer of at least 1, said $Z_n = X_n/Y$, said $X_n = (I_{1n}/J_1)M_{1n} + (I_{2n}/J_2)M_{2n} + \ldots + (I_{Kn}/J_K)M_{Kn}$, said Y and said I_{kn}, J_k, M_{kn} (k=1, 2, ..., K) each a positive integer, said K a positive integer of at least 1, said computer code including an algorithm, said algorithm programmed to:

set Z=0, B=0, and A_k=0 for k=1, 2, ..., K;

execute N iterations, wherein to execute iteration n of N includes:

to calculate a quotient Q_{kn} and a remainder R_{kn} from integer division I_{kn}/J_k for k=1, 2, ..., K;

to calculate $X_n = \Sigma_k\ [Q_{kn}M_{kn}]$ as summed over k from 1 to K;

to add $R_{kn}M_{kn}$ to A_k for k=1, 2, ..., K;

for k = 1, 2, ..., K, if $A_k \geq J_k$, then to add 1 to B and to decrement A_k by J_k;

if $Y \neq 1$ then to calculate a quotient Q_n and a remainder R_n from integer division X_n/Y, else to set $Q_n = X_n$ and $R_n = 0$;

to set $Z_n = Q_n$ and to add R_n to B;

if $B \geq Y$, then to calculate $Z_n = Z_n + 1$ and to decrement B by Y;

to add Z_n to Z.